SOIL STABILIZER FOR USE ON UNIVERSALLY ACCESSIBLE TRAILS

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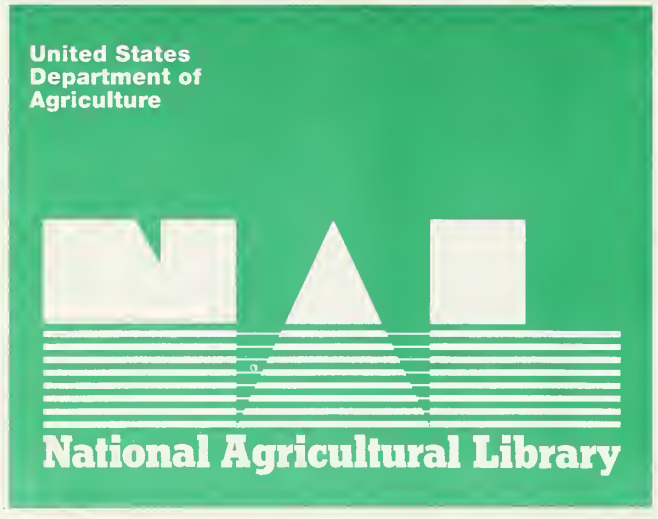

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Roger Bergmann
ME Technician

San Dimas Technology & Development Center
San Dimas, California 91773

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BACKGROUND

Many Forest Service trail sites are located in settings where concrete or asphalt paving for universal access are not consistent with the desired recreation experience. Techniques are available to improve the esthetic appeal of paved asphalt or concrete walkway surfaces, though they are not covered in this report. There are a number of products currently being marketed as soil stabilizers which hopefully meet the need of providing natural appearing trail surfaces that are both firm and slip resistant.

Over the past several years a number of Forest Service units, and other government agencies, have been using some of the soil stabilizers with less than complete satisfaction. The problems appear to be insufficient guidelines from the product manufacturers and users who have not been strict in following application specifications provided by manufacturers. However, it is possible that some products may not be as beneficial as the suppliers lead users to believe.

The Forest Service is currently establishing several trail test locations where a number of different products will be applied and monitored under the same soil and climatic conditions. The product types used in this study include: ground seed hulls, tree resin emulsion, latex polymers, bentonite, Class C flyash, enzymes, and asphalt emulsion macadam. These products will be tested under a number of different conditions including using either fine or course aggregates; sunny vs. shaded trail locations; and varying proportions and/or combinations of products. Since final test results will not be available for several years this report provides general guidelines and information to help achieve greater success when implementing a trail stabilization project.

REMEMBER: It is important to follow good construction practices.

GUIDELINES

The purpose of the products discussed in this report is to provide a more natural appearance to the finished trail while providing a firm, non-slip tread surface. These alternative products for hardening trail surfaces are not miracle workers, and they should not be used solely as a means to reduce construction costs. Suppliers may remark that these products can be used with the native soils and that no import materials need be used. This may be true, but there is concern as to their longevity and cost effectiveness, so be sure to ask the suppliers which types of soils work best with their products.

Trails are really small roadways for travel; though the loads are not heavy it is still important to have a proper design incorporated, particularly the necessary drainage requirements. Also, consult with the engineering staff before starting any accessible trail construction or improvement project. The plasticity index, optimum moisture content, and sieve gradation are important to know prior to using the stabilizer. This information will be helpful in deciding which type and quantity of stabilizer to use.

Base Course

Always plan on having a compacted base course, particularly if the project is located in a wet area or a location with moderate to high precipitation levels. The base course may be a granular native soil material, or an imported material that the engineering department has found to be suitable. Since trails are usually too narrow and meandering to allow for heavy construction equipment, and because of the lighter loads on trails, it is not necessary to meet the same compaction requirements as for roads. However, compaction of the base material is important and requires the best type of equipment available that is suitable for the site. If possible, use a steel-wheeled vibratory type roller, otherwise use nothing less than a vibratory plate compactor (figure 1) to compact the base material. Make sure that the material is near optimum moisture content, and make at least three passes with the vibration compaction equipment.

Figure 1—Vibratory plate compactor.

Some stabilizer products become as hard as asphalt or concrete, while other stabilizers soften somewhat when exposed to moisture, and then re-harden. In either case, if the base course fails, the surface course fails sooner.

Vegetation Problems

If the trail is located in an area where there is concern about vegetation growing up through the trail surface, consider using a non-woven construction fabric to help prevent vegetation damage. Use a non-woven fabric meeting AASHTO M208 criteria for Class B subsurface drainage with an apparent opening size greater than a No. 70 U.S. Standard Sieve. Another option is black plastic (4 mils or thicker), but be sure to poke some fine holes in the plastic for drainage. Existing vegetation must be killed or completely removed prior to placing the fabric. If possible, the fabric should be placed beneath the base course, but if it is placed on top of the base course there should be a minimum of 2 inches (51mm) of surface material over the fabric. If a rototiller is used to mix the stabilizing product with the surface materials, plan the depth of the fabric accordingly! Also, use a rototiller with the tines located at the back (figure 2). The machine is big and bulky but it is relatively easy to control the depth of the tines and it is remarkably maneuverable.

Figure 2—Rear-tined rototiller.

Trail Tread Surface

Stabilization of Imported Materials

Based on current experience, it is recommended that 3/8-inch (9.5 mm) minus trail surface material be imported when using any stabilizer product. Imported material should be very consistent in its' properties and the soil analysis information obtained will be very helpful in specifying the type and quantity of stabilizer needed. If the trail project is near a road, or is being designed for universal access, budget the additional funds necessary to import 3/8-inch (9.5 mm) minus trail surface material. If there is a good base course already, then 2 inches (51mm) of surface material should be enough. Otherwise, plan on at least 3 inches (76 mm) of stabilized tread material. The reasons for requiring the finer grade of material are ease in creating a smooth, visually appealing surface; improved universal accessibility; and a smooth tread that has smaller voids in the surface to prevent water from being trapped. Water can quickly break down the trail tread by softening the surface material or by freeze/thaw causing it to break apart.

Stabilization of Native Materials

If there is an immediate need, and importing surface material is not an option, it is possible to stabilize the native soil for the tread surface. If this method is used the trail will have a much shorter life span for several reasons:

1. Since only the surface material is being treated, there will not be a properly compacted base course.

2. Vegetation may begin to break down the tread surface prematurely because it was not feasible to place construction fabric under the native soil.

3. Drainage design and construction may be more difficult because compaction of the trail surface may create low spots that will collect water.

4. The native trail material may vary in type and size from one location to another, making it difficult to proportion the stabilizer.

PRODUCT APPLICATION

After a soil analysis has been completed, a sound decision can be made on the best type of product for the site. It is important to follow the guidelines of the manufacturer and supplier, since the correct application of any stabilizing product is necessary in order to monitor the effectiveness of the product.

It is advisable to prepare a test section to determine if the designed quantities appear to be correct. Construction of the test section also gives the work crew a chance to become familiar with the characteristics of the product, and what restrictions may be needed to maintain consistency throughout the application of the product.

It is also recommended that a control section be constructed into the trail. The control section should be the same type of imported or native material and constructed to the same standards as the rest of the trail, but without the added stabilizer product. This helps determine whether the added product actually provides a better stabilized surface, or if it would have been possible to simply moisten and compact the material without the extra expense of a stabilizer. This information will be very beneficial as future projects are planned and carried out.

TYPES OF SOIL STABILIZERS

Class "C" Flyash

Flyash is a byproduct obtained from the stacks of power plants that burn coal, and is available in different classes. Because the quantity of lime in coal deposits varies from place to place, the resulting flyash varies in the quantity of quicklime that it contains. Class "C" Flyash contains the necessary percentage of quicklime to be of benefit when stabilizing soils. The flyash works best if the material being stabilized has a plasticity index less than ten. The flyash causes a reaction that helps to cement the aggregate particles together. The reaction takes place when moisture is added, and it happens very quickly. Therefore, do not try to do too much at a time. Flyash can also be used to strengthen the base course, particularly if the trail is in a wet area.

Figure 3— Leveling trail after moisture added.

Flyash is very inexpensive provided there is a close source of supply; otherwise transportation increases costs. Plan to add about five percent flyash by dry weight of the materials being stabilized. It is best to do a test section to see if the percentage of flyash needs to be increased or decreased. Because of the quick reaction time, mix the flyash into the tread surface with a rototiller. The moisture in the soil begins the reaction, but additional water is required. Once moisture is added, the surface must be quickly leveled and compacted (figure 3) because the soil may set-up in as little as 15 minutes.

Caution-Flyash is very dusty; dust masks and eye protection may be necessary. Also, flyash, when reacting with water, releases heat which can cause skin burns.

SOURCE OF SUPPLY

Western Ash Company (4 Offices)
10410 Live Oak Ave.
Fontana, CA 92335
(909) 350-3155

216 Vista Glen Place
Martinez, CA 94553
(510) 370-7138

4380 Syracuse St., Suite 305
Denver, CO 80237
(303) 779-8366

5020 North 8th Place
P.O. Box 7360
Phoenix, AZ 85011
(602) 248-7946
(800) 528-6630

Bentonite

Bentonite is a clay type material found in natural deposits throughout the country. If the native trail tread course is lacking in clay material, the addition of three percent bentonite by dry weight may be all that is needed to stabilize the surface. The clay simply bonds the aggregate particles together. Be aware that too much bentonite can cause the material to become very slippery when wet.

Bentonite is also very inexpensive if there is a source nearby. Mix the bentonite in a pug-mill or cement mixer and then apply to the trail; or rototill the bentonite directly into the surface material.

Caution-Bentonite is very dusty; dust masks and eye protection may be necessary.

SOURCES OF SUPPLY

Willamette Graystone
(503) 388-3811
Central Oregon Bentonite
(503) 477-3351

Ground Seed Hulls

Stabilizer, a patented, organic, and non-toxic product is manufactured from the seed hulls of the plantego, a plant native to Arizona. Stabilizer is odorless; will not stain the materials that it is mixed with; and is safe for humans, animals, and vegetation. Stabilizer softens somewhat when subjected to moisture, but rehardens when dry. It has been used successfully in differing climatic conditions including heavy snow and freezing temperatures in Chicago, Illinois and Brooklyn, New York; heavy precipitation (60 inches or 1.5 m per year) in Huntsville, Alabama; moderate precipitation (20 inches or 0.5 m per year) in Pomona, California; and very hot temperatures with light precipitation in Phoenix, Arizona. Stabilizer works well with materials that are 3/8 inch (9.5 mm) and less in diameter, but will **not** bind larger aggregates and hold them in place. Most applications specify a 2-inch (51 mm) depth of surface materials, which requires approximately one pound (0.5 kg) of Stabilizer per 12 square feet(1.1m^2). It is important however to review suppliers installation directions prior to determining final design quantities.

Stabilizer is easy to repair and consequently makes it a good choice to use in areas that may have vegetation growing through the trail tread. The vegetation can be removed from the trail and the section repaired by scarifying the surface, rewetting, and compacting. If additional materials are needed use a similar aggregate as the original source to maintain a similar coloration. Mix the materials as for the original construction; place in location; grade and smooth; wet thoroughly; compact; and let dry.

Caution-Stabilizer is dusty; dust masks and eye protection may be necessary.

Stabilizer is sold in 20 lb.(9 kg) and 40 lb. (18 kg) bags.

SOURCE OF SUPPLY

Stabilizer
4832 East Indian School Road
Phoenix, AZ 85018
(602) 952-8009 (800) 336-2468

Pine Resin Emulsions

Pine resin is a byproduct from the distillation of turpentine. The pine resin emulsions contain approximately thirty percent rosin solids. As the water evaporates from the treated aggregates the surface becomes harder than asphalt cement. The resin basically binds the aggregate particles together. During the application process the liquid emulsion has a very strong foul odor, but should not prohibit the work being done. After the product cures there is no noticeable odor. Some application instructions recommend using only 0.15 gallons per square yard (0.6 liters per square meter). This quantity is more appropriate for dust abatement than trail stabilization. Plan to use one gallon per square yard (3.8 liters per square meter) for each one-inch (25.4 mm) of depth. Prepare a short test section to verify the quantity of emulsion required for the desired result in the specific application.

The emulsion can be mixed into the aggregate in a concrete mixer and then spread on the trail, or it can be spread over the trail surface and mixed in with a rototiller. The easiest way to spread the emulsion over the trail surface is to take a five gallon (19 liter) plastic bucket and punch many nail holes in the bottom. Calculate the square footage that four gallons (15 liters) will cover to the desired depth, and then quickly pour in four gallons (15 liters) from another container and move the bucket back and forth as the liquid drains through the nail holes (figure 4). The nail holes will plug up after several of these cycles because of the sticky nature of the solids. To keep

Figure 4—Pine resin being applied to trail surface.

the project moving along, use two application buckets; one can be kept in use while the other is being unplugged.

After spreading the emulsion over the surface, rototill until all the material applied is incorporated into the surface material. Level the materials after tilling and then compact with a roller or vibratory plate. Wipe diesel fuel over the vibratory plate at frequent intervals, otherwise the resin tends to stick to the plate and will cause scrape marks on the trail surface. Also, have a tool on hand to scrape the plate clean if material sticks to the surface.

Because this is a very messy job, it is recommend that the crew wears old clothes, long sleeved shirts, gloves, and rubber boots.

The supplier recommends that after the area cures for several days, the surface be sprayed with a sealer coat to prevent water from entering surface voids. The recommended application rate is approximately 0.15 gallons per square yard (0.6 liters per square meter). The application is difficult and the only suitable method found to work is a weed sprayer. Because of the solids in the emulsion the sprayer will plug up after spraying about two to three gallons (7.5 to 11 liters). It is then necessary to take off the spray tip and run a nail or wire through the holes to re-open them. The completed trail surface looks very good, but it is more expensive and time consuming than some of the other stabilization products.

SOURCE OF SUPPLY

Soil Stabilization Products Co., Inc.
(Road Oyl)
P.O. Box 2779
Merced, CA 95344
(209) 383-3296
(209) 383-7849 (FAX)

Latex Polymers

Latex polymers are a byproduct of the paint industry. Several Forest Service locations have attempted to use latex polymers for trail stabilization, but the completed projects have not been considered too successful. The latex polymers are applied in an emulsion, and as it dries the latex creates a coating that bonds the aggregate particles together. The products have been used with some success to prevent surface erosion until vegetation can grow to protect a slope. The products are also used for dust abatement on roads, but when there is traffic over the surface it tends to cause raveling, separation of the aggregate, and requires additional treatments as with most dust abatement products. At this time, the latex polymers seem to have a shorter life span than some of the other types of stabilizers. The life span can be increased by applying a seal coat every 2 to 3 years.

SOURCES OF SUPPLY

Midwest Industrial Supply, Inc.
(Soil Sement)
P.O. Box 8431
Canton, Ohio 44711
(216) 456-3121
(216) 456-3247 (FAX)

PM-10 Consultants (Eco-CF)
P.O. Box 4327
Cerritos, CA 90703
(310) 921-6391

Native Soil Technologies, Inc.
(Nasolid 2000)
5239 Sellers Avenue
Oakley, CA 94561
(510) 625-8411
(510) 679-8528 (FAX)

Enzymes

Bacterial culture is the active ingredient in enzyme solutions. Since the bacteria multiply very rapidly when exposed to the air, a small quantity of the enzyme products goes a long way. Depending on the product, only one gallon (3.8 liters) of enzyme stabilizer is needed for every 9 to 15 cubic yards (6.9 to 11.5 m^3) of aggregate [475 to 800 linear feet (145 to 244 m) of four-foot (1.2 m) wide trail]. Enzyme products have been shown to work very well in stabilizing road surfaces that have high clay content (10-15%), however, there have not been many well documented trail stabilization projects to date.

SOURCES OF SUPPLY

C.S.S. Technology, Inc. (EN-1)
P.O. Box 1355
Weatherford, TX 76086
(800) 541-3348

Pacific Enzymes (Perma-Zyme)
4608 Orange Grove Ave
Sacramento, CA 95841
(916) 645-0199

Soil Stabilization Products, Inc.
Earth Materials Catalyst (EMC²)
P.O. Box 2779
Merced, CA 95344
(209) 383-3296
(209) 383-7849 (FAX)

Macadam

Macadam is a trail construction technique that costs less than asphalt cement, yet uses a petroleum based emulsion. It consists of a layer of nonwoven geotextile covered with a 1/2 inch to 1 inch (13 to 25.4 mm) layer of aggregate chips. The chips are then coated with an asphalt emulsion at the approximate rate of 1.5 gallons per square yard (5.7 liters per square meter)(figure 5), which is then covered with a thin layer of blotter sand to conceal the black asphalt appearance. A Special Project Specification for macadam construction is available from San Dimas Technology and Development Center, or USDA Forest Service, Attn.: Steve Monlux, P.O. Box 7669, Fort Missoula, Missoula, Montana 59807.

Figure 5—Asphalt emulsion being applied to trail surface.

TRAIL SURFACING DATA BASE

The Forest Service is maintaining a National Trail Surfacing Data Base to keep appraised of where trail stabilization products are being used, what products are being used, and how well the products perform over time. Prior to beginning a trail stabilization project, please contact San Dimas Technology and Development Center for a Data Base Information Form. Upon completion of the project, please return the completed form for inclusion in the data base. As this information is compiled, it will be very helpful in the future to determine the best products for use on projects throughout the Forest Service, as well as other agencies.

"Non-Standard Stabilizers"
FHWA-FLP-92-011; July, 1992
U.S. Dept. of Transportation, Federal Highway Administration
Office of Direct Federal Programs
Washington, D.C. 20590

Available to the public from:
National Technical Information Service
Springfield, Virginia 22161

Engineering Field Notes

"Trail Hardening Test", (Gusey), Volume 23, May-June, 1991.

"Barrier Free Accessible Trail Surface Materials-Northern Region Materials Engineering Investigations", (Monlux), Volume 26, September-October, 1993.

"Surfacing Trails With Non-Standard Stabilizers", (Scholen), Volume 26, November-December, 1993.

Copies of Engineering Field Notes are available from:
USDA—Forest Service
Engineering Staff - Washington Office
Attn: Editor, Engineering Field Notes
P.O. Box 96090
Washington, D.C. 20090-6090
(202) 453-9420

Additional Information on soil stabilizers

USDA—Forest Service
Attn: Pete Bolander
P.O. Box 3623
333 S.W. 1st Ave.
Portland, Oregon 97208
(503) 326-3249
DG: P.Bolander:R06C

USDA—Forest Service
Attn: Steve Monlux
P.O. Box 7669
Fort Missoula
Missoula, Montana 59807
(406) 329-3870
DG: S.Monlux:R01A

USDA—Forest Service
San Dimas Technology & Development Center (SDTDC)
Attn: Recreation Program Leader
444 East Bonita Ave.
San Dimas, CA 91773
(909) 599-1267
DG: Mailroom:W07A

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